National Institute of Environmental Health Sciences

Redistribution of organic pollutants in river sediments and alluvial soils related to major floods

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Abstract:

Background, Aims, and Scope: More frequent occurrence of stronger floods in Europe as well as in other parts of the world in recent years raises major concern about the material damages, but also an important issue of contamination of the affected areas through flooding. The effects of major floods on levels and distribution of contamination with hydrophobic organic pollutants were examined from the continuous set of data for floodplain soils and sediments from a model industrial area in the Czech Republic where a 100-year flood occurred in 1997. The goal of this study was to evaluate the risk related to contamination associated with such extensive natural events and characterize the spatial and temporal distribution and dynamics of pollutants related to a major flooding shortly after the floods and also in the time period several years after floods. Methods: Sediments and alluvial soils from fourteen sites each were repeatedly sampled during the period from 1996 until 2005. The sampling sites represented five regions. Collected top-layer sediment and soil samples were characterized and analyzed for hydrophobic organic pollutants PCBs, OCPs and HCB using GC-ECD and PAHs using a GC-MS instrument. Spatial and temporal differences as well as the relative distribution of the pollutants were examined in detail by statistical analysis including multivariate methods with special emphases placed on the changes related to floods. Results: The organic pollutants levels in both alluvial soils and sediments exceeded the safe environmental limits at numerous sites. Pollutants concentrations and relative distribution as well as organic carbon content in both sediment and floodplain soils were significantly affected by the flooding, which resulted in a decrease of all studied contaminants in sediments and significant rise of the PAH pollution in the flooded soils. There was a unique and highly conserved PAH pattern in soils regardless of the floods and greater changes in PAH pattern in sediments related to floods. The relative distribution of individual PAHs reflected a combustion generated PAH profile. PAH levels in the river sediments rose again at the sites with continuous sources several years after floods. Discussion: The results showed different dynamics of PAHs and PCBs during the floods when PAHs were redistributed from the sediments to alluvial soils while PCBs have been washed out of the study regions. The data reveal longer contamination memory and consistent contamination pattern in soils, whereas sediments showed more dynamic changes responding strongly to the actual situation. The stable PAH pattern within the regions also indicates that a relative amount of all compounds is comparable across the samples and, thus, that the sources at different sites have similar character. Conclusions: Sediments have the potential to function as a secondary source of contamination for the aquatic ecosystem, but also for the floodplain soils and other flooded areas. The floods served as a vector of PAHs contamination from sediments to soils. The reloading of river sediments in time, namely with PAHs, due to present sources increases their risk as a potential source in the next bigger flood event both to the downstream river basin and affected alluvial soils. Recommendations and Perspectives: The results stress the importance of including the floodplain soil contamination in the risk assessment focused on flood effects. Floodplain soils

have stable long-term environmental memory related to contamination levels, pattern and distribution, whereby they can provide relevant information on the overall contamination of the area. The sediments will continue to serve as a potential source of contaminants and alluvial soils as the catchment media reflecting the major flood events, especially until effective measures are taken to limit contamination sources.

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Resource Description

Exposure :

weather or climate related pathway by which climate change affects health

Extreme Weather Event, Food/Water Quality

Extreme Weather Event: Flooding

Food/Water Quality: Chemical

Geographic Feature:

resource focuses on specific type of geography

Freshwater

Geographic Location:

resource focuses on specific location

Non-United States

Non-United States: Europe

European Region/Country: European Country

Other European Country : Czech Republic

Health Impact:

specification of health effect or disease related to climate change exposure

Health Outcome Unspecified

Mitigation/Adaptation:

mitigation or adaptation strategy is a focus of resource

Adaptation

Resource Type:

format or standard characteristic of resource

Research Article

Timescale:

time period studied

Time Scale Unspecified

Vulnerability/Impact Assessment: ☑

resource focus on process of identifying, quantifying, and prioritizing vulnerabilities in a system

A focus of content